

CLAIMS

Thus, having described the systems and methods for confirming electrical connection defects, we claim the following:

1. A method for confirming defects, comprising the following steps:
 - dividing the surface of a printed circuit board into a plurality of views;
 - associating an electrical connection with a corresponding view when a characteristic associated with the connection in an observed image indicates that the connection is defective;
 - analyzing the corresponding view to determine the slope of the surface of the printed circuit board across the view;
 - adjusting the distance between the printed circuit board and a sensor in response to the slope of the view; and
 - observing the characteristic associated with the connection in a subsequent image.
2. The method of claim 1, further comprising:
 - considering the connection acceptable when the characteristic observed in the subsequent image is within a range of expected values.
3. The method of claim 2, further comprising:
 - ignoring the acceptable determination from observation of a subsequent image when the characteristic associated with the connection is indicative of a specific defect.
4. The method of claim 2, further comprising:
 - ignoring the acceptable determination from observation of a subsequent image when the connection is associated with a specified device type.
5. The method of claim 3, wherein the defect is a short circuit.
6. The method of claim 4, wherein the specified device type is a ball-grid array device.

1 7. The method of claim 2, further comprising:
2 ignoring the acceptable determination from observation of a subsequent image
3 when the connection is associated with a plated through hole.

1 8. The method of claim 1, wherein the step of observing comprises:
2 deriving an adjustment range corresponding to the distance between the
3 printed circuit board and a focal plane of a sensor;
4 determining a number of adjustment steps contemplated to cover the
5 adjustment range;
6 repeating the adjusting and observing steps until the characteristic observed in
7 the subsequent image is within a range of accepted values.

1 9. The method of claim 8, further comprising:
2 considering the connection acceptable when the characteristic observed in the
3 subsequent image is within the range of accepted values.

1 10. The method of claim 1, wherein the step of observing comprises:
2 deriving an adjustment range for a focal plane of the sensor;
3 determining a number of adjustment steps to cover the adjustment range;
4 repeating the adjusting and observing steps until the number of adjustment
5 steps has been exhausted and the characteristic observed in each of the subsequent
6 images indicates that the connection is defective.

1 11. The method of claim 10, further comprising:
2 reporting that the connection is defective.

1 12. The method of claim 11, wherein the step of reporting comprises
2 storing an indicator that the connection failed a reexamination.

1 13. The method of claim 1, wherein the step of analyzing the
2 corresponding view comprises identifying a centroid of the view.

1 14. The method of claim 13, further comprising:
2 identifying the z-height of the centroid.

1 15. The method of claim 14, wherein the z-height of the centroid is
2 identified using a surface map of the printed circuit board.

1 16. The method of claim 14, wherein the step of adjusting comprises
2 assuming that the corresponding view is coplanar with a surface map plane that
3 encompasses the centroid.

1 17. The method of claim 14, wherein the step of adjusting comprises
2 determining the maximum height deviation between each of the vertexes of the
3 corresponding view and the centroid.

1 18. An improved circuit board inspection system, comprising:
2 means for segmenting a surface of a circuit board in response to an indication
3 that an electrical connection on the circuit board is defective;
4 means for associating the defective electrical connection with a corresponding
5 segment; and
6 means for observing a characteristic of each defective electrical connection
7 that accounts for variation in height of the surface of the circuit board over the
8 corresponding segment.

1 19. The system of claim 18, wherein the means for segmenting divides the
2 surface of the circuit board into a plurality of rectangular segments.

1 20. The system of claim 19, wherein each of the plurality of rectangular
2 segments encompasses an equivalent area of the surface.

1 21. The system of claim 19, wherein the means for observing adjusts a
2 focal plane of a sensor.

22. The system of claim 21, wherein the focal plane of the sensor is
adjusted in steps responsive to the maximum deviation in height across the segment.

23. The system of claim 22, further comprising:
means for reporting that an electrical connection is acceptable when the
characteristic observed in a subsequent image is within an acceptable range.

24. The system of claim 23, further comprising:
means for filtering acceptable electrical connection determinations forwarded
by the reporting means when the characteristic associated with the electrical
connection is indicative of a specified defect condition.

25. The system of claim 23, further comprising:
means for filtering acceptable electrical connection determinations forwarded
by the reporting means when the electrical connection is formed from a solder ball.

26. The system of claim 23, further comprising:
means for filtering acceptable electrical connection determinations forwarded
by the reporting means when the electrical connection is associated with a plated-
through hole.

27. The system of claim 21, wherein the focal plane of the sensor is
adjusted in steps over a sensor adjustment range.

28. The system of claim 27, wherein the focal plane of the sensor is
adjusted until the sensor reaches a limit of the sensor adjustment range.

29. The system of claim 27, wherein the focal plane of the sensor is
adjusted until the characteristic observed in each of the subsequent images indicates
that the electrical connection is defective.

30. The system of claim 29, further comprising:
means for reporting that the electrical connection is defective.

31. The method of claim 30, wherein the means for reporting comprises setting an indicator that the electrical connection has failed a reexamination.

32. A defect confirmation program stored on a computer-readable medium, comprising:

logic configured to segment a surface of a circuit board in response to an indication that at least one of a plurality of electrical connections is defective;

logic configured to associate the at least one defective electrical connection with a corresponding segment;

logic configured to adjust the focal plane of a sensor that accounts for variation in height of the surface of the circuit board across the corresponding segment;

logic configured to record a characteristic of the at least one defective electrical connection;

logic configured to identify the electrical connection as acceptable in response to a condition where a measured characteristic value falls within a designated range;

logic configured to supersede a previous indication that the electrical connection is defective in response to the logic configured to identify.

33. The program of claim 32, wherein the logic configured to segment divides the surface of the circuit board into a plurality of rectangular segments.

34. The program of claim 33, wherein each of the plurality of rectangular segments encompasses an equivalent area.

35. The program of claim 32, wherein the logic configured to adjust varies the focal plane of a sensor.

36. The program of claim 35, wherein the focal plane of the sensor is varied in steps responsive to the slope of the segment.

37. The program of claim 32, further comprising:

logic configured to mark an electrical connection acceptable when a measurement of the characteristic observed in a subsequent image is within an accepted range of values.

38. The program of claim 37, further comprising:

logic configured to remove the mark when the characteristic associated with the electrical connection is indicative of a short circuit condition.

39. The program of claim 37, further comprising:

logic configured to remove the mark when the electrical connection is associated with a ball-grid array device.

40. The program of claim 37, further comprising:

logic configured to remove the mark when the electrical connection is associated with a plated-through hole.

41. The program of claim 32, wherein the logic configured to adjust varies

the distance between the focal plane of a sensor and the center of the corresponding segment in steps over a sensor adjustment range until the characteristic observed in an image is within an acceptable range.

42. The program of claim 32, wherein the logic configured to adjust varies

the distance between the focal plane of a sensor and the center of the corresponding segment in steps over a sensor adjustment range until the focal plane reaches a limit of the sensor adjustment range.